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A Member of The IT Group

M60050.002504
MCAS EL TORO
SSIC #5090.3

December 12, 2000

Mr. Richard Selby, Code 02R1.RS
Contracting Officer
Naval Facilities Engineering Command, Southwest Division
1220 Pacific Highway
San Diego, California 92132-5187

Attn: Ms. Lynn Marie Hornecker

Re: Well Closure Report
Abandoned Water supply Well No. 5 (AW-5) at
Marine Corps Air Station, El Toro, California
SWDIV Contract Number: N68711-93-D-1459
DCN SW 9166, Delivery Order Number: 0070

This Well Closure Report describes the well inspection activities conducted to confirm destruction of the former water supply well AW-5, located at Marine Corps Air Station (MCAS) El Toro (herein after the Station). OHM Remediation Services (OHM) conducted this work on behalf of the Navy under the Southwest Division Naval Facilities Engineering Command (SWDIV) Contract No. N68711-93-D-1459, Delivery Order (DO) 0070.

Site Location

The Station is located approximately 45 miles southeast of Los Angeles in Orange County, California, one mile north of the intersection of Interstate 5, the Santa Ana Freeway, and Interstate 405, the San Diego Freeway (Figure 1). The abandoned Water supply Well No. 5 (AW-5) is located in the southwest portion of the Station, just south of Taxi Way T-5 (Figure 2). North American Datum (NAD) 83 coordinates, for the well cap location, are provided in Table 1.

Table 1, NAD 83 Coordinates for AW-5

Northing	Easting
2190466.6281	6108345.0964

Site Background

Phase II Remedial Investigation (RI) Report of Site 24 (Bechtel National, Inc. (Bechtel), 1997) investigated six abandoned water supply wells, identified during the Phase I RI as potentially being present at Site 24. Norcal, a subcontractor to BNI, conducted a geophysical survey as part of the Phase II investigation and reported locating wells AW-1, AW-4, AW-5, and AW-6, with a possible location of AW-3. A copy of the Norcal report is enclosed as Attachment A.

BNI reported that of the six water supply wells three were located. BNI also reported that AW-4 was inspected and was found to be open to groundwater. BNI also excavated and photographed AW-5 (included in the Phase II RI Report); however, there was no text describing the inspection of AW-5 and it was unclear if the well had been destroyed. A copy of the pertinent text and the photograph is included in Attachment B.

Subsequently, abandoned water supply wells AW-1 and AW-4 were destroyed according to California Well Standards. OHM was tasked to investigate the remaining well locations (AW-3, AW-5, and AW-6) and to determine the current condition of these wells. The following is a report of the inspection of AW-5, confirming the apparent destruction of the AW-5 well according to California Well Standards (California Department of Water Resources Bulletin 74-81, 1981, and Bulletin 74-90, 1990).

Well Inspection Activities

The well inspection activities included a review of existing records, a geophysical survey of the indicated well locations to confirm and locate the presence of the well casing, excavation of the well casing and inspection.

Records Review

Historic well location records including maps and reports dating back to approximately 1948 were reviewed to assess potential locations of these wells. The geophysical investigation conducted by Norcal Geophysical consultants, photographs, and descriptions presented in the Draft Final Phase II Remedial Investigation Report Operable Unit 2A – Site 24 were also reviewed. These data were used to focus the OHM investigation at these sites.

Geophysical Location Investigation

Geovision, an OHM subcontractor, conducted a geophysical investigation at AW-5 in May 2000. A copy of the report is enclosed in Attachment C.

After reviewing available historical maps and reports of the well, a magnetometer and electromagnetometer were utilized to conduct the survey. A 10 by 10-foot survey grid was established in the vicinity of the suspected well location, and a data logger in conjunction with single-frequency global positioning system (GPS) was used to record data collected in the survey area. Three geophysical anomalies were indicated in the report, A-1, A-2 and A-3. A-1 was interpreted to be AW-5 or infrastructure associated with the well. A-2 was a

narrow, somewhat linear anomaly, believed to be the abandoned water line associated with the well. A-3 was believed to be a metallic object associated with the nearby runway.

Excavation and Inspection

The recommendations from the geophysical survey results were used to establish the excavation boundary for well AW-5. The excavation was advanced at A-1 location, removing the top seven feet of soil in order to expose the top of the well casing for inspection.

In the excavation OHM observed a concrete well vault and the remains of the steel piping used to transport the water from the well vault. The sides of the approximately 8 feet by 12 feet vault had been demolished, possibly during well abandonment activities. The bottom of the well vault had a jagged hole broken in the concrete. A circular mushroom shaped concrete plug was located in the center of the hole in the vault floor. The concrete mushroom shape appears to be the top seal that would extend above the top of the well casing. following California Well Standards. The concrete from the cap appears to have been allowed to fill the hole in the vault floor. The location is consistent with the A-1 geophysical anomaly interpreted to be the abandoned AW-5 water supply well. Consistent with the A-2 geophysical anomaly, an approximately 6-inch diameter pipeline, believed to be the water distribution pipe, was found connected to the on the north vault wall. Photographs of the well vault are provided in Attachment D. OHM contacted Orange County Health Care Agency (OCHCA) on July 10, 2000 and discussed field excavation activities. OHM findings indicate that well AW-5 has been previously destroyed.

Summary and Recommendation

During inspection of the AW-5 well location, a circular mushroom shaped concrete cap was observed, consistent with the top concrete plug that would have been installed during the destruction of a well following California Well Standards. The well cap was approximately seven feet below ground surface in a concrete vault. Following inspection, the excavation was backfilled.

OHM recommends that this information be submitted as evidence that water supply well designated as AW-5 appears to have been previously destroyed following California Well Standards, and *no further action* is needed at this site.

Should you have any questions or comments, please feel free to contact the undersigned at (949) 261-6441.

Sincerely,

OHM Remediation Services Corporation,

Julie Erickson
Geologist

Dhananjay Rawal
Project Manager

References

Bechtel National Inc. 1997. *Draft Final Phase II Remedial Investigation, MCAS El Toro.* March 1997.

California Department of Water Resources. 1981. Water Well Standards: State of California, Bulletin 74-81, pp.52-57.

California Department of Water Resources. 1990. California Well Standards, Bulletin 74-90, pp. 60-65.

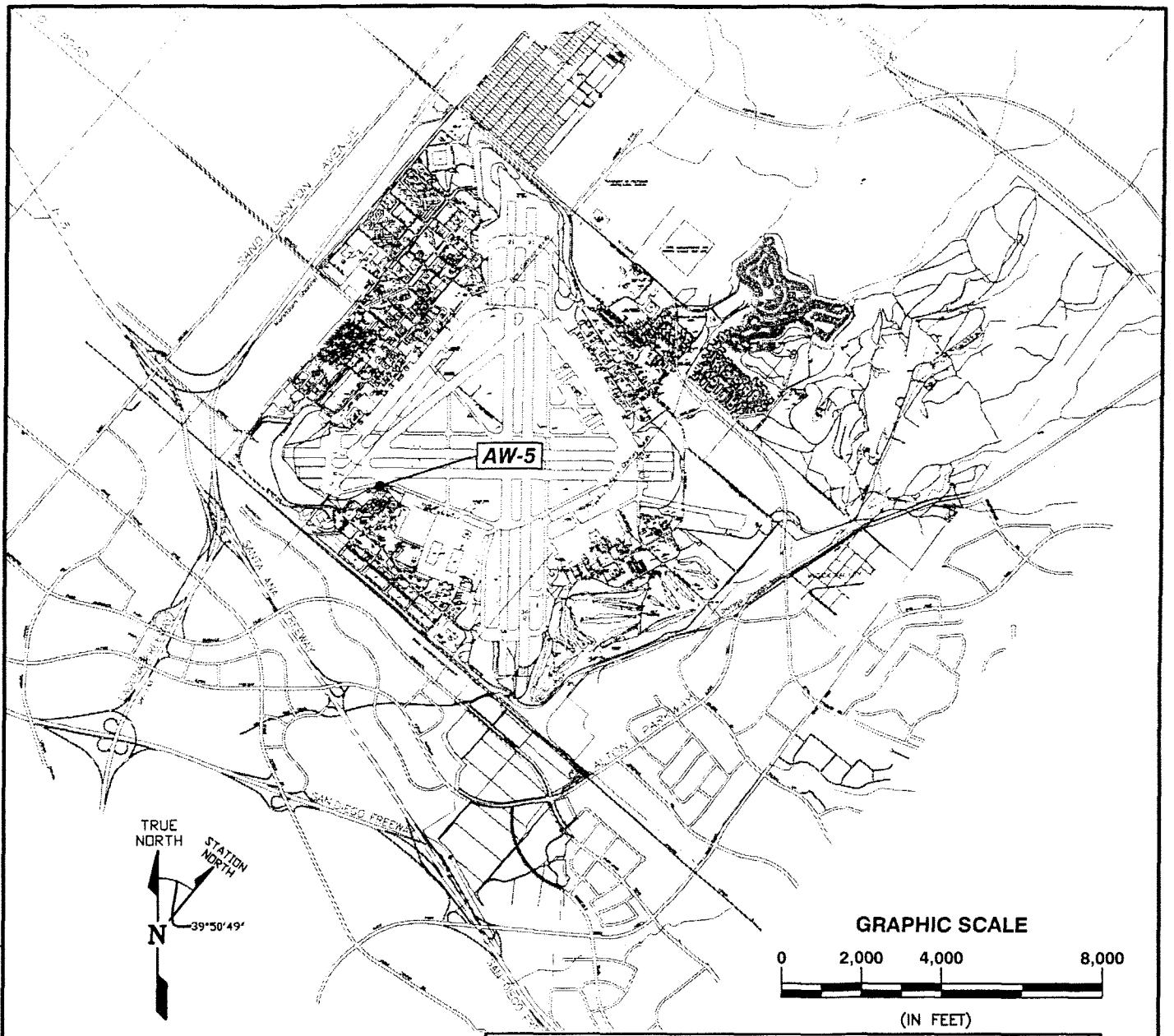
Figures:

Figure 1	Facility Location Map
Figure 2	Location of Abandoned Water supply Wells

Attachments:

Attachment A	Norcal Geophysical Survey
Attachment B	Excerpts from BNI Phase II RI Report
Attachment C	Geovision Geohysical Investigation
Attachment D	Photographic Log

Figures



GRAPHIC SCALE

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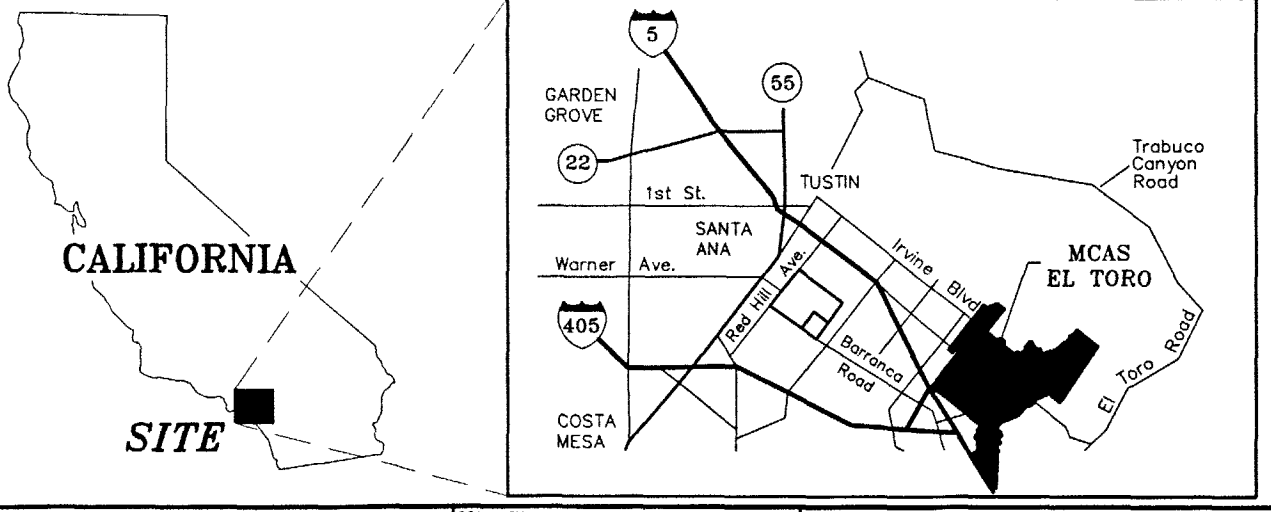
(IN FEET)



OHM Remediation Services Corp.
A Subsidiary of OHM Corporation
SAN DIEGO, CA

CONTRACT NAME: SWDIV

DRAWN BY: R. PIRMORADIAN	DATE: 9/29/00	
CHECKED BY:	DATE: 12/12/00	
APPROVED BY:	DATE:	
PROJECT MANAGER: DR	DATE: 12/12/00	

FACILITY LOCATION MAP
ABANDONED WATER WELL AW-5

MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

AUTOCAD FILE No.	PLOT SCALE	SHEET	OF	SCALE	DOCUMENT CONTROL No.	OHM PROJECT No.	FIGURE No.	REVISION
18609346A.DWG	1=1	1	1	1"=4,000'	SW9166	18609	FIG 1	0

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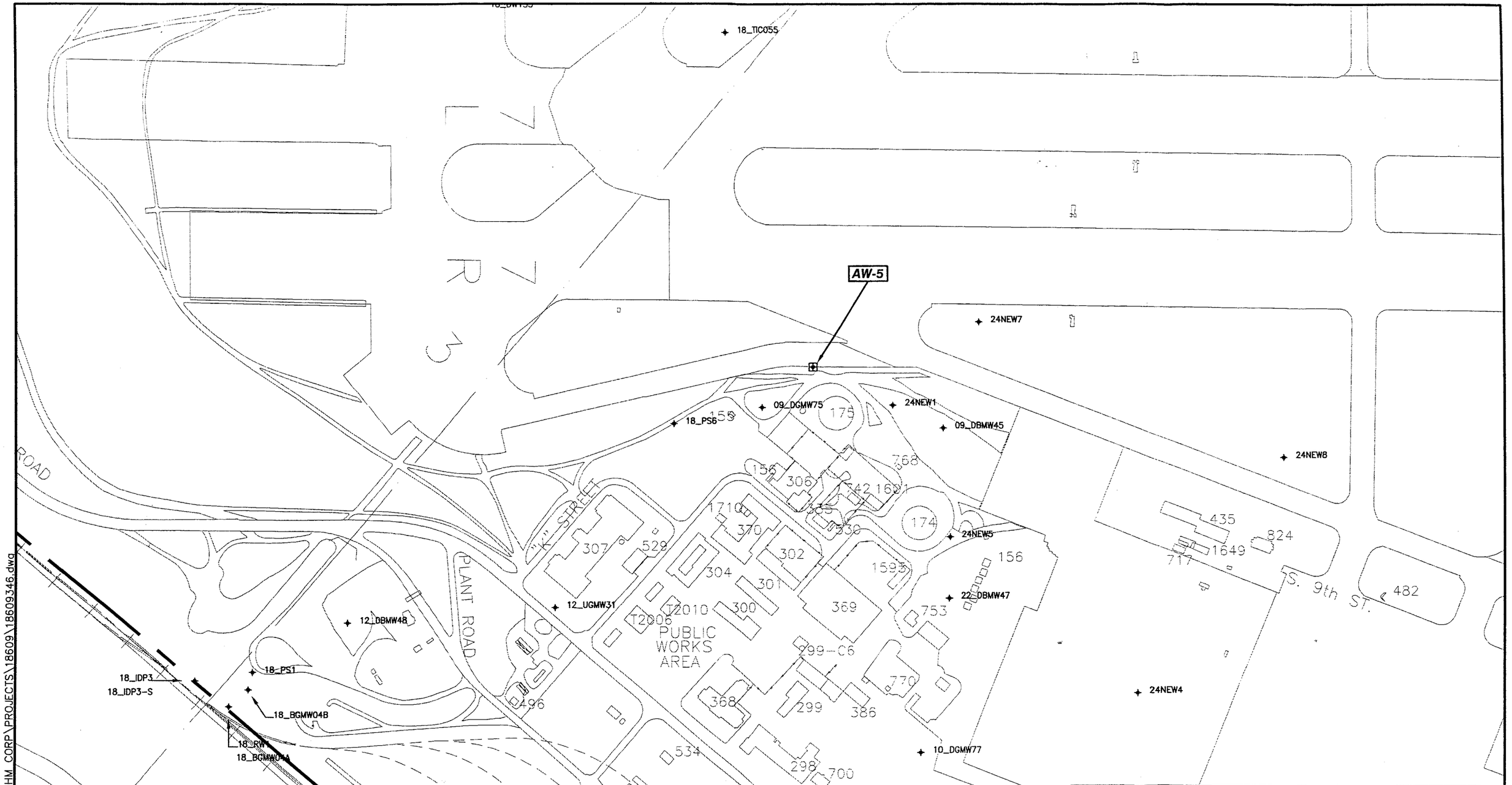

EXPLANATION:

AW-5 ABANDONED WATER WELL NO. 5

GROUNDWATER MONITORING WELL

GRAPHIC SCALE

(IN FEET)

REVISIONS			
REV. No.	DESCRIPTION	DATE	APPROVED

CONTRACT NAME	SWDIV
DRAWN BY	R. PIRMORADIAN
DATE	9/29/00
CHECKED BY	JE
DATE	12/12/00
APPROVED BY	
DATE	
PROJECT MANAGER	DR
DATE	12/12/00
AUTOCAD FILE No.	18609346.DWG
SCALE	1"=300'
SHEET	1
OF	1
DOCUMENT CONTROL No.	SW9166
OHM PROJECT No.	18609
DRAWING No.	FIG 2

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IRVINE, CA

LOCATION MAP
ABANDONED WATER WELL AW-5

MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

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Attachments

Attachment A
Norcal

M60050.002504
MCAS EL TORO
SSIC # 5090.3

ATTACHMENT A
NORCAL GEOPHYSICAL SURVEY

AS PER RPM (L. HORNECKER) THE ABOVE IDENTIFIED APPENDIX IS AN EXCERPT. SOME PARTS OF THE TABLE OF CONTENTS WERE NOT ISSUED.

QUESTIONS MAY BE DIRECTED TO:

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NORCAL

ABANDONED WELL INVESTIGATION AND BOREHOLE CLEARANCE SURVEYS MARINE CORP AIR STATION (MCAS) EL TORO, CA

A report prepared for

Bechtel National, Inc.
401 West A Street, Suite 1000
San Diego, California 92101-79505

Bechtel Job No. 22214
NAVY CLEAN II PROGRAM
Subcontract No. 22214-P01-2276A-TSC
DO#001 - CTO#073

by

Donald J. Kirker
Geophysicist GP-997

Kenneth G. Blom
Geophysicist GP-887

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707/763-1312
NORCAL Job Number 95-383.01

September 15, 1995

NORCAL

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LIST OF ILLUSTRATIONS

NORCAL

1.0 INTRODUCTION

This report presents the findings of a geophysical investigation performed by NORCAL Geophysical Consultants, Inc. at the Marine Corp Air Station (MCAS), El Toro, California. The geophysical investigation consisted of two tasks. The field survey for both the abandoned well search and the proposed borehole investigation was conducted during the period of July 25 through August 3, 1995 by Geophysicist, Donald J. Kirker, and Geophysical Technician, Ted Heinse. Logistical support was provided by Kleinfelder personnel Paul Stoppelmann. The investigations were conducted under Subcontract No. 22214-PO1-2276A, for Delivery Order No. 001 (CTO-073 MCAS El Toro).

1.1 Purpose

Historical information indicates that domestic water was supplied to the MCAS by on-base water wells. Several of these wells have since been abandoned. MCAS El Toro utility maps show the general locations of these wells, however their exact locations are not known. Therefore, the purpose of the geophysical investigation is to investigate six sites for possible abandoned well casings. Since the potential well sites will be excavated by Bechtel, a second objective is to locate detectable utility alignments and potential obstructions in the general vicinity of the possible abandoned wells. This investigation is designated as Task 1. Other work by Bechtel will include the drilling of 137 borings. In order to minimize the potential for encountering utilities and other possible drilling obstructions, a geophysical survey was conducted at each proposed drill location. We have designated this survey as Task 2.

1.2 Site Description

The geophysical investigations for both tasks were performed at various sites within Operable Unit (OU) 24 and OU-25 at the MCAS El Toro. The abandoned well casing investigation was conducted at five sites within OU-24. These are referred to as Abandoned Well #1, #3, #4, #5, and #6. The investigation at Abandoned Well #2 could not be performed due to strong magnetic interference from a metal interlocking

mat that covers the survey area. This mat could not be removed during the period of our investigation. Detailed descriptions of each of the five other sites follow.

The proposed boring investigation was also conducted within OU-24 and a limited area in OU-25. Of the 137 locations, seven locations could not be investigated because of interferences caused by metal ground cover overlaying the respective survey areas. These locations are designated as 24CPT53, 24CPT52, 24CPT48, 24CPT47, 24CPT67, 24B33, and 24B32. The 130 locations that were investigated included a wide range of site conditions. These conditions include close proximity to buildings and roadways, within flight line facilities, as well as open accessible areas.

2.0 METHODOLOGY

For the abandoned well investigation, we used the vertical magnetic gradient (VMG), ground penetrating radar (GPR), and electromagnetic line locating (EMLL) methods. The VMG method was used to determine the presence of buried ferrous metal that may represent an abandoned well casing. Since the potential well sites will be excavated by Bechtel, we also used the GPR and EMLL methods to investigate the immediate site for detectable utility alignments and other possible subsurface obstructions.

For the borehole site clearance, we used the GPR and EMLL to investigate each proposed boring location for detectable utility alignments, as well as other possible drilling obstructions. Descriptions of the VMG, GPR, and EMLL methods are provided below.

2.1 Vertical Magnetic Gradiometer

A magnetic gradiometer measures the vertical gradient of the earth's magnetic field. It consists of two total field magnetic sensors separated vertically by one-half meter. The magnetic field strength is measured simultaneously at both of these sensors. The difference in magnetic intensity between these measurements is proportional to the vertical gradient of the earth's magnetic field. Because the vertical gradient is constant with respect to time, the effect of diurnal variations is eliminated. Therefore, a gradiometer provides higher sensitivity and better resolution of near surface sources than total field magnetometers. Areas with significant amounts of buried metal typically produce anomalously steep magnetic gradients. Since it is sensitive to ferrous metal sources both above and below ground, site and vicinity surface conditions can affect survey results.

We used an EDA OMNI IV tie-line magnetometer to obtain the vertical magnetic gradient data. The instrument features a built-in memory that stores the vertical magnetic gradient and survey grid information. The information can be down loaded to a computer for further processing.

2.2 Ground Penetrating Radar

Ground penetrating radar is a method that provides a continuous, high resolution cross-section depicting variations in the electrical properties of the shallow subsurface. The method is particularly sensitive to variations in electrical conductivity and electrical permittivity (the ability of a material to hold a charge when an electrical field is applied).

The system operates by continuously radiating an electromagnetic pulse into the ground from a transducer (antenna) as it is moved along a traverse. Since most earth materials are transparent to electromagnetic energy, only a portion of the radar signal is reflected back to the surface from interfaces representing variations in electrical properties. When the signal encounters a metal object, however, all of the incident energy is reflected. The reflected signals are received by the same transducer and are printed in cross-section form on a graphical recorder. Depending upon depth and/or thickness the resulting records can provide information regarding the location of UST's, underground utilities, and variations in the shallow site materials. Generally, electrically conductive materials, such as saturated clay and significant rebar can reduce the penetration capability and limit radar performance.

For this investigation, we used a Geophysical Survey Systems, Inc. SIR-3 Subsurface Interface Radar System equipped with a 500 megahertz (Mhz) antenna. This antenna is near the center of the available frequency range and is used to provide high resolution at shallow depths. High resolution is important when the accurate location of utility alignments is necessary.

2.3 Electromagnetic Line Location

Electromagnetic line location techniques are used to locate the magnetic field resulting from an electric current flowing on a line. These magnetic fields can arise from currents already on the line (passive) or currents applied to a line with a transmitter (active). The most common passive signals (ambient) are generated by live electric lines and reradiated radio signals. Active signals can be introduced by connecting the transmitter to the line at accessible locations. The conducted signal

(current) will travel along the specific utility. This is referred to as electromagnetic conduction (EMC). Conversely, a signal can be introduced to a line by electromagnetic induction (EMI). This procedure requires the transmission of an electromagnetic field in close proximity to the utility. Typically, the transmitter is on the ground surface. The transmitted field will induce a current into the subsurface and through the line.

The detection of underground utilities is dependent upon the composition and construction of the line of interest. Utilities detectable with standard line location techniques include any continuously connected metal pipes, cables/wires or utilities with tracer wires. Unless carrying a passive current these utilities must be exposed at the surface or in accessible utility vaults. These generally include water, electric, natural gas, telephone, and other conduits related to facility operations. Utilities that are not detectable using standard electromagnetic line location techniques include those made of nonelectrically conductive materials such as pvc, fiberglass, vitrified clay, and pipes with insulated connections.

Our instrumentation for this investigation consisted of a Radiodetection RD-400 line locator and a Fisher TW-6 inductive pipe and cable locator.

3.0 ABANDONED WELL CASING INVESTIGATION

As mentioned above, the abandoned well casing investigation was conducted at five sites within OU-24. A brief description of data acquisition, data analysis, and results for this work is presented below.

3.1 Data Acquisition

We collected VMG data at 10 foot intervals (stations) along east-west or north-south trending traverses. The traverses were spaced 10 feet apart and extended the length of each survey area. Following the data acquisition, we contoured the VMG data in the field using a portable laptop computer. We then made preliminary interpretations from these contour maps and determined possible location(s) for the respective abandoned well casing.

Following this initial investigation, we then used the GPR and EMLL methods over each interpreted well location. This was conducted along two perpendicular traverses. The intersection of the traverses was positioned over the interpreted well location. Each traverse was approximately 20 ft. long. Detected utilities and subsurface features, that may represent potential obstructions during the excavation of these wells, were identified and marked with spray paint on the ground surface. The GPR and EMLL data was used to locate possible associated facilities, not to locate the specific abandoned well.

3.2 Data Analysis

3.2.1 VMG Data Computer Processing

The magnetic data were down loaded from the magnetometer to a field computer. The computer processing included conversion of the data into a format that can be used in a contouring software routine. This contouring package was used to calculate an evenly spaced array of values (gridded) based on the observed field data. Finally, these gridded values were contoured to produce the vertical magnetic gradient contour maps for the various sites.

3.2.2 Contour Map Interpretation

Generally, magnetic values vary smoothly throughout a given region. Within culturally active areas, the ambient vertical magnetic gradient can be relatively large. In comparison, the anomalies produced by buried magnetic sources may be relatively small or subtle. Areas where magnetic variations are strong are defined by closely spaced contours and are typically considered anomalous. If the source of a particular anomaly is an isolated object or a group of closely spaced objects, the contours may form circular or elliptical closures. Depending upon proximity, a large accumulation of buried objects may appear as a group of closely spaced anomalies or one large anomaly.

Actual anomaly magnitude and shape are dependent on the relative position and size of the buried objects with respect to the location of the data points. In general, anomaly magnitude will decrease and anomaly width will increase as distance (depth) to the source increases. Anomalies may or may not have paired high and low values creating what are known as magnetic dipoles.

Our experience has shown that buried well casings can produce anomalies with varying shape and size. Magnetic anomalies associated with well casings typically produce closely spaced contours that exhibit high intensities and form positive peaks. However, there are cases where these anomalies may manifest low or negative values. This is dependent on the depth to the top of the casing, as well as on the amount of other buried metal (associated piping, etc.) that still exists. Typically, metal well casings can produce VMG anomalies that range from 400 to over 2,000 g/m.

3.2.3 GPR Data Analysis

As mentioned above, GPR profiles were obtained over magnetic gradient anomalies that may be due to a possible abandoned well. The GPR data were examined for hyperbolic reflection patterns characteristic of underground utilities. They were also examined for changes in reflection character that may indicate fill material associated with utility trenching.

3.3 Results

The results of the geophysical investigation for the MCAS El Toro are presented on Plates 1 through 10. Plates 1, 3, 5, 7, and 9 represent the site location maps for each area. These maps show the limits of the survey area, as well as any structures or above ground cultural features that may be in close proximity to the site. The plates also show the suspect well location based on site diagrams provided by Bechtel. This is indicated by a large "X" .

The results of our findings at each site are also included on the location maps. These include the location of the interpreted VMG anomalies (taken from the VMG Contour Map) and the surface trace of the detected utilities. The anomalies represent areas containing buried metal that may indicate the existence of a well casing. At one of the sites (Abandoned Well #4), a primary and two secondary anomalies are indicated. The primary anomaly represents the anomaly that we interpret as most likely produced by a well casing. The secondary anomalies represent areas where there is a higher possibility of other magnetic sources. Anomalies due to above ground cultural features are not shown. The surface trace of the detected utilities are shown on these plates. Typically, they are utilities that are located in relatively close proximity to the possible well casings. These plates may not indicate all of the underground utilities that may exist in the VMG survey area.

Plates 2, 4, 6, 8, and 10 represent the respective VMG contour maps for each survey area. These contour maps represent the variations in the vertical magnetic gradient throughout the sites. Areas with strong variations that cannot be accounted for by above ground sources are the anomalous areas described above and shown on the location maps. The magnetic gradient contour interval for the various VMG maps ranges from 50 to 200 g/m. The varying contour intervals were arbitrarily selected based upon the specific intensities and for clarity of presentation. The VMG contour maps indicate the northing and easting horizontal control grid.

3.3.1 Abandoned Well #1

The area of investigation, as specified by Bechtel personnel, is shown on Plate

1. It is a soil covered parcel that measures approximately 40 ft. by 300 ft. and is located adjacent to taxiway T-5 and north of Bldg. 295. Two large metal blast shields are located along the north boundary. Electrical vaults are located in southeast and southwest corners of the survey area.

The results of the VMG survey are presented on the Location Map and Vertical Magnetic Gradient Contour Map, Plates 1 and 2, respectively. The closely spaced contours along the northeast boundary represent effects caused by the metal blast shields to the north. The contours that form circular closures in the southwest and southeast corners represent effects caused by the electric vaults. The circular contours located along 112E do not appear to be associated with any above ground cultural features. We interpret this anomaly as being possibly associated with Abandoned Well #1. The center of this anomaly is approximately 57 ft. southeast of the suspect well location as identified by Bechtel. We have marked the center of this anomaly in the field with a surveyors brush flag. The location of this anomaly is shown on Plate 1.

The GPR and EMLL survey, conducted in the vicinity of this anomaly, resolved the location of an electric line. The surface trace of this utility is shown on Plate 1.

3.3.2 Abandoned Well #3

The area of investigation is shown on the Abandoned Well #3 Location Map, Plate 3. It is an asphalt covered parking lot that measures approximately 75 ft. by 110 ft. The site is bound by Bldg. 369 to the north, and a undesignated building to the south. A large metal dumpster is located in the southwest corner of the site. A reinforced concrete slab is located in the southeast corner.

The results of the VMG survey are presented on the Location Map and Vertical Magnetic Gradient Contour Map, Plates 3 and 4, respectively. The contour map indicates a series of anomalies that extend north along 80E. We believe that these anomalies represent effects caused by a buried utility line, as shown on Plate 3. The contours that form circular closures in the southeast corner probably represents effects caused by the reinforced concrete pad and building. The closely spaced

contours along the northern boundary represent effects caused by the loading dock and building to the north. However, there is a small isolated anomaly within these linear contour lines associated with the dock. This anomaly may represent effects from a possible well casing located out of the survey area. The center of this anomaly is approximately 8 ft. west of the suspected well location, as identified by Bechtel. Due to the close proximity of the loading dock, a utility investigation was not conducted at this site.

3.3.3 Abandoned Well #4

The area of investigation is shown on Plate 5. This site is a portion of an asphalt covered parking lot that measures approximately 90 ft. by 90 ft. It is located at the northwest corner of 14th Street and L Street. The site is bound by stored metal equipment to the south and a chain link fence to the east. A reinforced concrete pad is located in the northeast portion of the survey area.

The results of the VMG survey are presented on the Location Map and Vertical Magnetic Gradient Contour Map, Plates 5 and 6, respectively. The closely spaced contours in the northeast and southeast corners represent effects caused by parked vehicles. However, the VMG anomalies that form circular closures in the central portion of the survey area are not associated with any above ground cultural features. Since there are multiple anomalies in the center of the site, we have designated them as primary and secondary VMG anomalies on Plate 5. As mentioned above, the primary anomaly represents the anomaly that we interpret as most likely produced by a well casing. This is based primarily on the magnitude of the anomaly. It has been our experience that buried well casings typically produce anomalies with high magnitudes. This anomaly is located over the concrete slab and is approximately 27 ft. northwest of the suspect well location as identified by Bechtel. We have marked its location in the field using spray paint. The secondary anomalies are also marked in the field with surveyors brush flags.

The GPR and EMLL survey, conducted in the immediate vicinity of the VMG anomalies, resolved the location of an undifferentiated utility line. We show this line

as a metal pipe on Plate 5. This line trends north from the concrete pad where the primary anomaly is located. MCAS El Toro utility maps, provided by Bechtel, show a water line trending north from the abandoned well location. This detected utility line may represent the water line shown on the MCAS El Toro utility map.

3.3.4 Abandoned Well #5

The area of investigation is shown on Plate 7. It is a gravel covered parcel that measures approximately 100 ft. by 80 ft. The survey area is located northwest of the above ground water tank designated as Bldg. 175. and is adjacent to taxiway T-5.

The results of the VMG survey are presented on the Location Map and Vertical Magnetic Gradient Contour Map, Plates 7 and 8, respectively. The closely spaced contours along the northwest boundary represent effects caused by an electric vault located out of the survey area. The contour map indicates a high magnitude anomaly in the central portion of the survey area that is not associated with any above ground cultural features. Therefore, it may represent effects caused by Abandoned Well #5. The center of this anomaly corresponds with the suspect well location as identified by Bechtel (shown on Plate 7). We have marked its location in the field using surveyors brush flags.

The GPR and EMLL survey, conducted in the immediate vicinity of this anomaly, resolved the location of an electric and water line. The surface trace of these utilities enter the survey area in the southwest corner and terminate at the center of the anomaly. The suspect utilities are also shown on Plate 7.

3.3.5 Abandoned Well #6

The area of investigation is shown on Abandoned Well #6 Location Map, Plate 9. The survey area represents a portion of the asphalt/concrete covered tarmac located north of Bldg. 96. The site measures approximately 100 ft. by 100 ft. and is bound by a chain link fence to the west and south. Light poles are located in the northwest and southwest corners of the survey area.

The results of the VMG survey are presented on the Location Map and Vertical Magnetic Gradient Contour Map, Plates 9 and 10, respectively. The closely spaced

contours along the northwest and southwest boundaries represent effects caused by the chain link fence. The circular contours located along 70E do not appear to be associated with any above ground cultural features. We interpret this anomaly as possibly being associated with Abandoned Well #6. The center of this anomaly is approximately 40 ft. northeast of the suspect well location as identified by Bechtel. We have marked its location in the field with white marking paint.

The GPR and EMLL survey, conducted in the immediate vicinity of this anomaly, resolved the location of two undifferentiated utility lines. The surface traces of these metal pipes are shown on Plate 9.

NORCAL

4.0 PROPOSED BORING INVESTIGATION

The investigation of the 130 proposed drilling locations was conducted throughout OU-24 and portions of OU-25. The 130 locations comprise of 76 CPTs, 42 auger borings, 5 extraction wells, 5 piezometer wells, and 2 air-sparging. The specific locations of these proposed borings were marked in the field by Bechtel with spray paint and stakes prior to our investigation. An OU-24 site diagram was provided by Bechtel showing directions to each boring location. Bechtel personnel accompanied us to the sites that required special access.

The locations of the proposed boreholes were generally separated by significant distances, however several sites were located in close proximity to each other. Of the 130 proposed locations, 28 of the above CPT locations were marked by Bechtel within 2 ft. of auger boring locations. The 5 extraction wells mentioned above were located within 40 ft. of the piezometer well locations. Since several locations could be included in one survey area, this resulted in a total of 83 survey areas.

4.1 Data Acquisition

The investigation at each of the proposed boring locations was conducted in a systematic approach. Our general approach is as follows:

A. Review MCAS El Toro site utility maps: After arriving at a specific proposed boring site, we reviewed the Bechtel provided site utility maps. Notes were made of any utilities that may extend into or through the survey area.

B. Conduct reconnaissance investigation over the area: We visually inspected the survey area and vicinity for evidence of the utilities that were indicated on the Bechtel provided site maps. We also looked for additional utilities that may be exposed at the ground surface within the general area.

C. Locate accessible and/or exposed utilities: If accessible utilities were evident near the survey area, we attempted to locate the underground extensions using the EMC, EMI, and ambient procedures as described above. Detected utilities within these areas were identified and marked with spray paint on the ground surface.

D. Conduct a GPR investigation over the specific boring locations: GPR profiles were obtained along both north-south and east-west trending traverses. The boring location was positioned at the intersection of these traverses. Each traverse was approximately 25 feet long. We examined the GPR records for hyperbolic reflection patterns characteristic of underground utilities. We also reviewed the records for reflection patterns that may indicate possible localized objects or fill material associated with utility trenching. Any possible utility alignment, as well as localized GPR anomalies, were identified and marked with spray paint on the ground surface.

E. Conduct an EMLL investigation over the specific boring locations: The EMLL systems were operated over each boring location within the same 25 foot diameter mentioned above. Detected utilities and subsurface features within these areas were identified and marked with spray paint on the ground surface.

F. Mark the final location on the ground surface: Following the utility map review, and the GPR and EMLL surveys, a final borehole site was resolved by determining a location that was clear of detectable subsurface features. We then marked the final borehole locations on the ground as white circles, with the letter "N" indicated in the center. The "N" indicates that NORCAL (as opposed to other subcontractors) surveyed the location. When possible, we also marked the location with wooden stakes and/or surveyor brush flags.

G. Fill out Borehole Clearance Log: Upon completing the site survey, we drafted a field map on the borehole clearance log showing the identified utilities, the boring location, and any above ground features in the immediate area. The 83 borehole clearance logs are included in Appendix A.

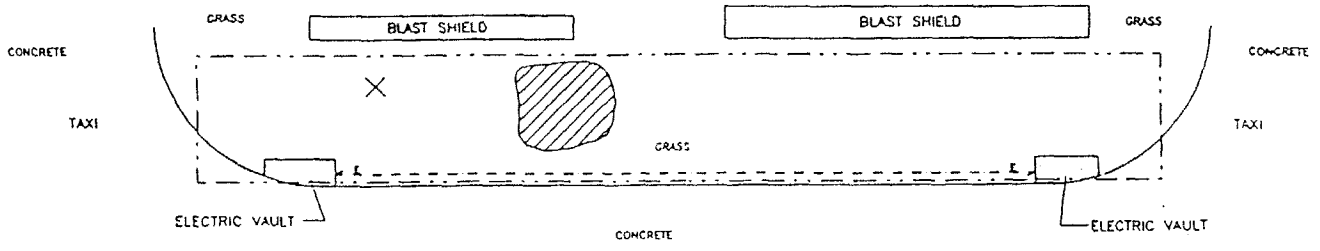
NORCAL

ILLUSTRATIONS

NORCAL

5.0 STANDARD CARE AND WARRANTY

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the shallow subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the level of skill ordinarily exercised by members of the profession currently employing similar methods. No other warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.



LEGEND

- LIMITS OF VLG SURVEY
- ELECTRIC LINE
- VLG ANOMALY
- SUSPECT WELL LOCATION BASED ON BECHTEL PROVIDED INFORMATION

0 30 60
SCALE (FT)

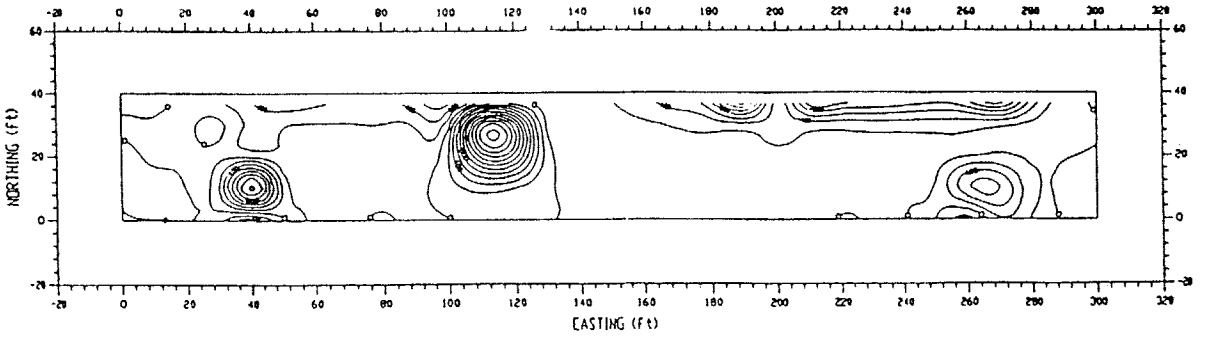
ABANDONED WELL #1
LOCATION MAP

GEOPHYSICAL INVESTIGATION
001-(TO-073, SUB CO / 22214-PG1-2276A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

PLATE 1

JOB 95-383.01 | APPR | DATE 8/95



LEGEND

VERTICAL MAGNETIC GRADIENT (VMG) CONTOUR
CONTOUR INTERVAL = 200 g/m

0 30 60
SCALE (FT)

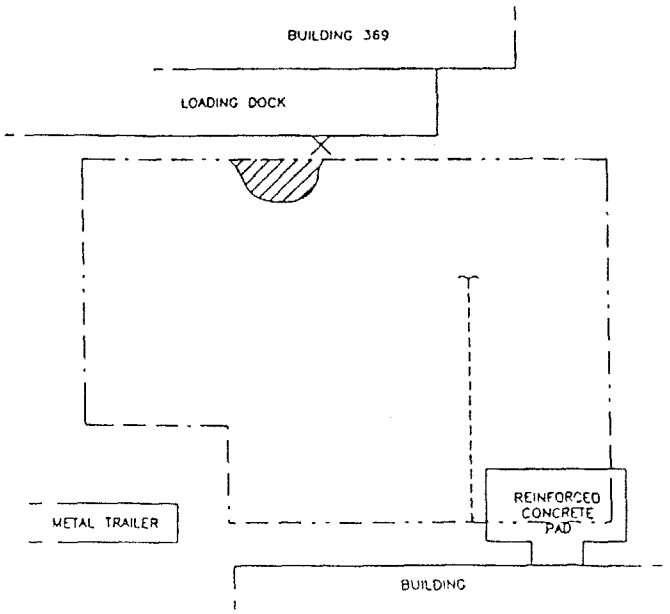
ABANDONED WELL #1
VERTICAL MAGNETIC GRADIENT
CONTOUR MAP

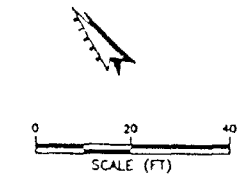
GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO./ 22214-P01-2276A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

PLATE 2

JOB 95-383.01 | APPR. | DATE 8/25





LEGEND

- LIMITS OF VLF SURVEY
- METAL PIPE
- SUSPECT WELL LOCATION BASED ON BECHTEL PROVIDED INFORMATION
- VLF ANOMALY

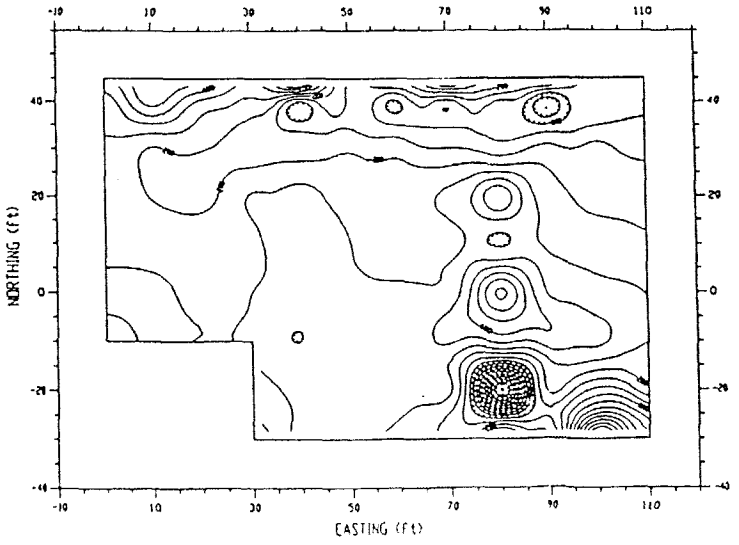
ABANDONED WELL #3
LOCATION MAP

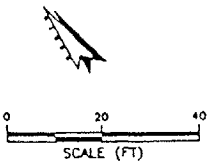
GEOPHYSICAL INVESTIGATION
001-010-073, SUB CO # 22214-P01-2278A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS INC

PLATE 3

JOB 95-383.01 | APPR: DSF | DATE: 8/95





LEGEND

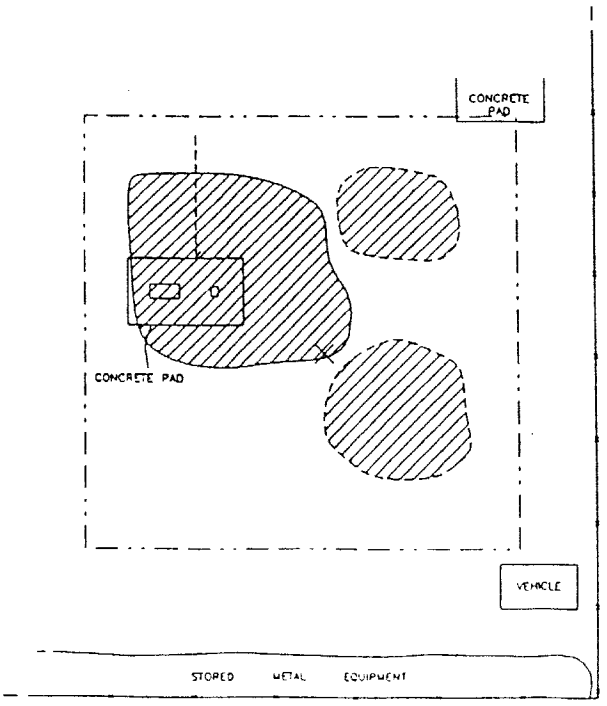
VERTICAL MAGNETIC GRADIENT (VMG) CONTOUR
CONTOUR INTERVAL = 200 g/m

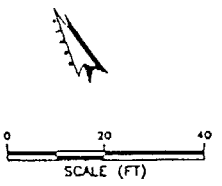
ABANDONED WELL #3
VERTICAL MAGNETIC GRADIENT
CONTOUR MAP

GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO # 22214-P01-2276A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

PLATE 4





LEGEND

- LIMITS OF VLG SURVEY
- METAL PIPE
- FENCE
- SUSPECT WELL LOCATION BASED ON BECHTEL PROVIDED INFORMATION
- PRIMARY VLG ANOMALY
- SECONDARY VLG ANOMALY

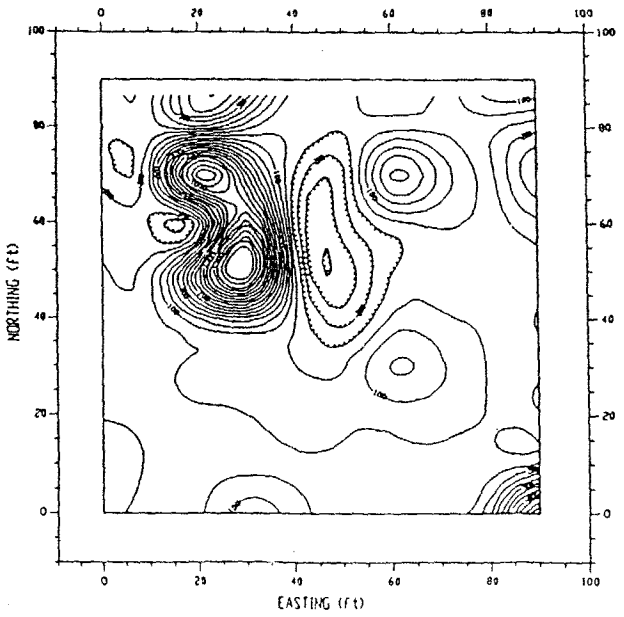
ABANDONED WELL #4
LOCATION MAP

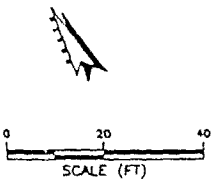
GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO # 22214-PG1-2375A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

PLATE 5

JOB: 95-383.01 | APPR: | DATE: 8/95





LEGEND

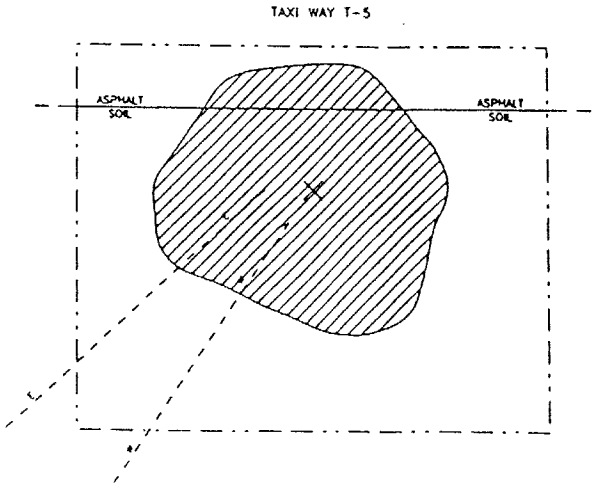
VERTICAL MAGNETIC GRADIENT (VMG) CONTOUR
CONTOUR INTERVAL = 100 g/m

ABANDONED WELL #4
VERTICAL MAGNETIC GRADIENT
CONTOUR MAP

GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO # 22214-P01-2256A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

JOB: 95-383.01 | APPR | DATE: 8/95



0 20 40
SCALE (FT)

LEGEND

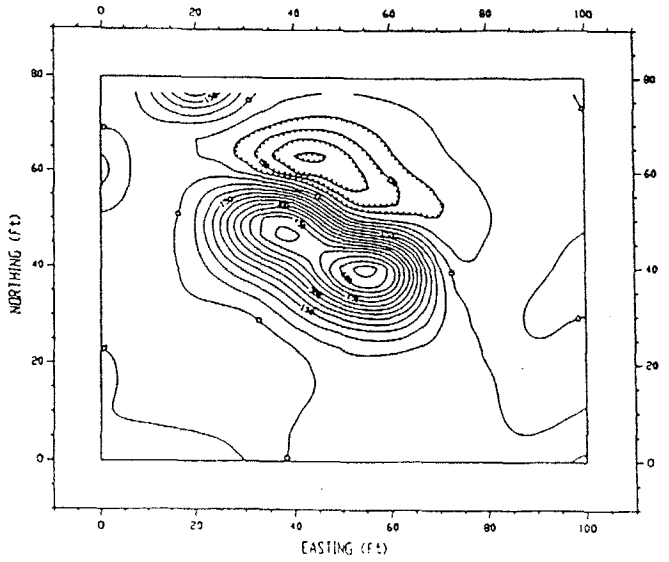
- LIMITS OF VMG SURVEY
- ELECTRIC LINE
- WATER LINE
- SUSPECT WELL LOCATION BASED ON BECHTEL PROVIDED INFORMATION
- VMG ANOMALY

ABANDONED WELL #
LOCATION MAP

GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO. / 2221A-P
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

JOB: 98-383.01 | APPR | DATE



0 20 40

SCALE (FT)

LEGEND

VERTICAL MAGNETIC GRADIENT (VMG) CONTOUR
CONTOUR INTERVAL = 50 g/m

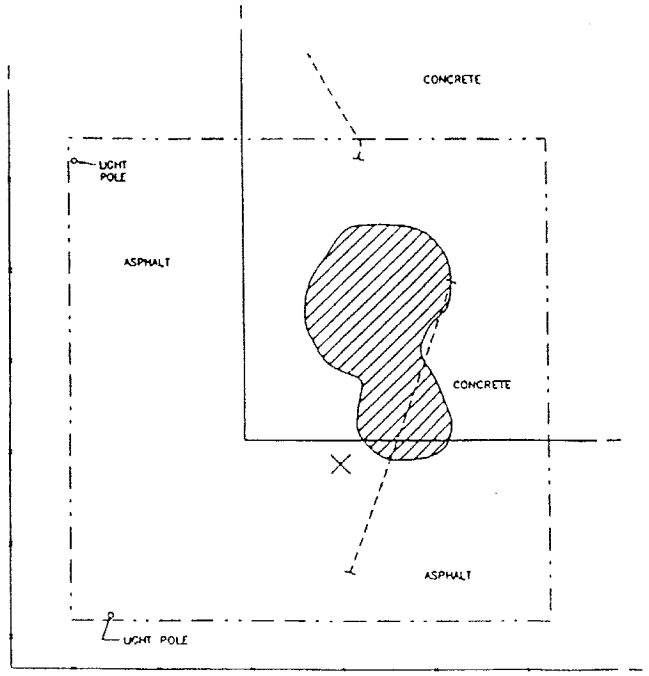
ABANDONED WELL #5
VERTICAL MAGNETIC GRADIENT
CONTOUR MAP

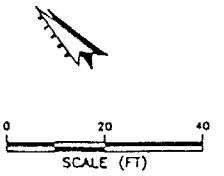
GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO.# 22214-P01-2275A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS INC

PLATE 8

JOB: 95-383.01 | APPR: | DATE: 8/95





LEGEND

- LIMITS OF VMG SURVEY
- METAL PIPE
- FENCE
- SUSPECT WELL LOCATION BASED ON BECHTEL PROVIDED INFORMATION
- VMG ANOMALY

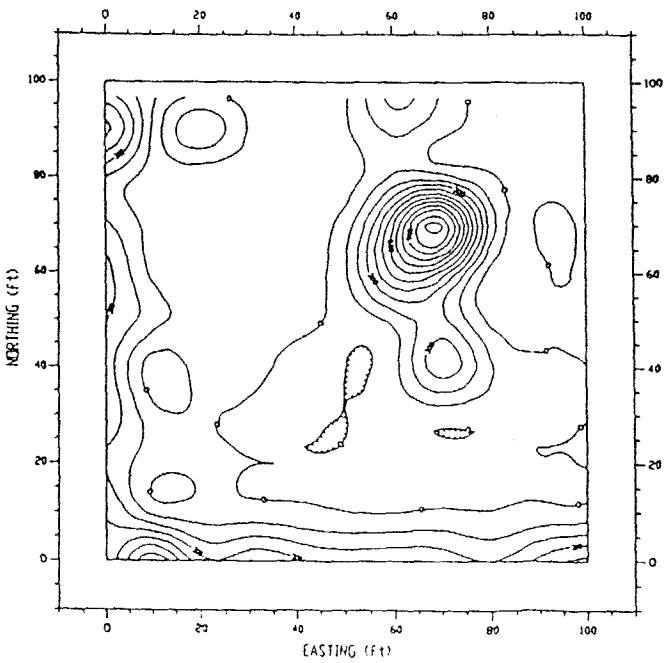
ABANDONED WELL #6
LOCATION MAP

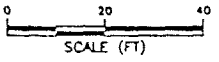
GEOPHYSICAL INVESTIGATION
001-CTO-073, SUB CO # 22214-PO1-2275A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS, INC.

PLATE 9

JOB: 95-383.01 | APPR: | DATE: 8/95





LEGEND

VERTICAL MAGNETIC GRADIENT (VMG) CONTOUR
CONTOUR INTERVAL = 100 g/m

ABANDONED WELL #6
VERTICAL MAGNETIC GRADIENT
CONTOUR MAP

GEOPHYSICAL INVESTIGATION
001-GTO-073, SUB CO. # 22214-P01-2276A
MCAS EL TORO, CA

NORCAL GEOPHYSICAL CONSULTANTS INC.

JOB: 95-383.01 | APPR: DT | DATE: 8/95

PLATE 1

Attachment B
Excerpts from BNI Phase II RI Report

The assessment of potential sources involved the following:

- review of MCAS El Toro employee interviews;
- review of MCAS El Toro engineering drawings;
- review of aerial photographs;
- review of existing data on USTs; and
- investigation of abandoned water-supply well locations.

Results of the potential source investigation are presented in Sections 3 and 4.

2.2.1 Review of MCAS El Toro Employee Interviews

Employee interviews regarding current and historical operations at the Station, with focus on waste disposal practices, were conducted by the Navy and by Jacobs Engineering (Jacobs Engineering 1994a). These interviews were reviewed as part of the Phase II investigation to assist in determining what potential contaminant storage, usage, and disposal practices were in effect at MCAS El Toro.

2.2.2 Review of Engineering Drawings

MCAS El Toro engineering drawings were used to determine locations within buildings where solvents, especially solvents containing TCE, may have been used (e.g., paint shops, degreaser pits) and to identify storm drain and industrial waste sewer line tie-ins and discharge points. Drawings reviewed included floor plans of Buildings 296, 297, and 324. These buildings are located above areas of elevated VOC concentrations in soil gas identified during the Phase I investigation.

2.2.3 Review of Aerial Photographs

Aerial photographs were analyzed to assess natural and man-made surface features at suspected solvent-use areas. Current and historical photographs were reviewed to determine how land usage at Site 24 has varied over time.

2.2.4 Review of UST Data

A database containing information on USTs was obtained from the 1995 Base Realignment and Closure Plan (BNI 1995j). This database was reviewed to determine UST locations, contents, construction, dates of use, and potential to contain VOCs now or in the past.

2.2.5 Investigation of Abandoned Well Locations

Station records indicated the presence of six abandoned water-supply wells on Site 24. If these wells were not abandoned properly, the potential for cross-contamination of VOCs from the water table to deeper portions of the aquifer exists (BNI 1995a). The investigation of suspected locations was performed by NORCAL Geophysical

Consultants, Inc., in July and August 1995 using vertical magnetic gradient and electromagnetic line-locating methods. Three of the wells were located. Two appeared to be abandoned with grout. The third contained water. A video log was completed for this well. Photographs of the video logging procedure are shown in Appendix A. In addition, water samples were collected to evaluate VOC concentrations in the abandoned well to help determine whether the well should be reconditioned or abandoned with grout. Three wells were not located.

2.3 SURFACE WATER AND SEDIMENT INVESTIGATIONS

Surface water and sediment samples are being taken as part of the Site 25, Major Drainages, investigation. Surface water sampling at the site was delayed due to lack of rain and took place on 31 January 1996. A report for Site 25 presenting the results of sampling activities will be issued as an addendum to this RI report.

2.4 VADOSE ZONE INVESTIGATION

The vadose zone investigation provided data used to: 1) characterize the nature of VOC contamination from the point of release or detection to groundwater; 2) characterize the VOC fate and transport in the vadose zone; and 3) perform a baseline human-health risk assessment (HRA). The vadose zone investigation consisted of soil gas and soil sampling and analysis.

2.4.1 Soil Gas Sampling

The Phase I RI sampling and analysis program demonstrated that soil gas sampling was the most effective way to characterize the nature and extent of VOCs in the vadose zone. The Phase I soil gas results effectively characterized the nature and extent of VOCs to a maximum depth of 30 feet below ground surface (bgs). The Phase II investigation extended this investigation by sampling for VOCs from approximately 30 feet bgs to groundwater and accomplished the following:

- provided a comparative analysis of Phase I and Phase II soil gas results;
- characterized the nature and extent of VOCs from 30 feet bgs to groundwater;
- provided data to evaluate the potential presence of residual dense nonaqueous-phase liquid (DNAPL); and
- provided data to calculate equilibrium soil VOC concentrations in soil moisture used in the fate and transport analysis.

Soil gas sampling and analysis were performed by Environmental Support Technologies, Inc. (EST), from August through November 1995. Sample collection was facilitated with a 20-ton cone penetrometer test (CPT) rig used to drive the soil gas probe to the appropriate depth. CPT services were provided by Gregg In Situ, Inc. Before soil gas samples were collected, the stratigraphy beneath the sample location was characterized with the CPT. The CPT provided lithologic information inferred from correlations

oil/water separators. These features serve as a line of defense against the release of free-phase contaminants off-Station.

3.1.3.4 ABANDONED INDUSTRIAL SEWER LINES

Station utility maps indicated that Buildings 324, 359, 312, and 297 were connected to a network of industrial wastewater sewer lines. The locations of the industrial wastewater sewer lines are shown on Figure 3-1. As-built drawings for Building 324 indicate that six degreaser pits in this building are connected to the industrial wastewater sewer line (Figure 3-4). Based on an interview with a retired Station employee, the industrial sewer lines were installed in 1945 and used for only 6 months (Jacobs Engineering 1993a). The lines were constructed of vitrified clay and may have received waste that included solvents and metal plating wastes. These waste were discharged to the Industrial Wastewater Treatment Plant, located south of the site.

3.1.3.5 ABANDONED AGRICULTURAL WELLS

Six abandoned agricultural wells were identified at Site 24 during the Phase I RI. The locations of these wells are shown in Figure 2-7. The six wells were assessed as part of the Phase II investigation. Of the six wells, only one was found to be open to groundwater, two were grouted, and three were not located. The static water level measured in abandoned well No. 4 (AW-4) was approximately 112 feet bgs. A water sample collected from the well contained 12 µg/L TCE. Appendix A includes photographs illustrating the investigation of AW-4.

3.2 WEATHER AND CLIMATE

MCAS El Toro has a Mediterranean climate, characterized by cool, moist winters and warm, dry summers. Early morning fogs are typical in late spring and early summer. Annual precipitation averages 12.2 inches, and most of the rainfall occurs from November to April. Winter temperatures seldom drop below freezing. The mean low temperature is 37 degrees Fahrenheit (°F). Summer temperatures rarely exceed 100°F. Night temperatures are generally cool throughout the year. From March through October, the prevailing wind is from the west and averages 6 knots. From November through February, the prevailing wind is from the east and averages 4 knots. During the late fall and early winter, strong, dry, gusty, offshore winds (known locally as "Santa Ana" winds) are common. Table 3-1 provides monthly average temperatures, precipitation, and wind speeds for the MCAS El Toro area.

3.3 SURFACE-WATER HYDROLOGY

Surface drainage on MCAS El Toro generally flows southwest, perpendicular to the trend of the Santa Ana Mountains. Several washes originate in the hills northeast of MCAS El Toro and flow through or adjacent to the base en route to San Diego Creek. None of these washes flow year round. Storm water runoff from the hills and upgradient irrigated

Attachment C
Geovision Geophysical Survey

GEOVision
geophysical services
a division of Blackhawk Geometrics

GEOPHYSICAL INVESTIGATION

Abandoned Water Well Numbers 3, 5 and 6
Marine Corps Air Station, El Toro, California

GEOVision Project No. 0260

Prepared for

The IT Group
3347 Michelson Drive, Suite 200
Irvine, California 92612-1692

Prepared by

GEO*Vision* Geophysical Services
1785 Pomona Rd, Suite B
Corona, CA 92880
(909) 549-1234

June 16, 2000

M60050.002504
MCAS EL TORO
SSIC # 5090.3

ATTACHMENT C
GEOVISION GEOPHYSICAL INVESTIGATION

AS PER RPM (L. HORNECKER) THE ABOVE IDENTIFIED APPENDIX IS AN EXCERPT. SOME PARTS OF THE TABLE OF CONTENTS WERE NOT ISSUED.

QUESTIONS MAY BE DIRECTED TO:

DIANE C. SILVA
RECORDS MANAGEMENT SPECIALIST
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132

TELEPHONE: (619) 532-3676

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

A geophysical investigation was conducted between May 16 and June 8, 2000 at Marine Corps Air Station (MCAS) El Toro in an attempt to locate three abandoned water wells. These water wells included Abandoned Water Well No. 3 (AW-3), AW-5, and AW-6.

Each geophysical survey area was selected after review of pertinent maps and documents, as discussed in the next section. Geophysical techniques used during this investigation included the magnetic and electromagnetic (EM) methods. These techniques complement one another as each responds to different physical properties or subsurface materials and has different strengths and limitations. The magnetic method was applied to this investigation because it has the greatest depth of investigation and has the strongest response to well casing. The EM technique was applied because it can map buried metallic pipes and other infrastructure associated with the wells at much greater resolution than a magnetometer.

The limited data review is presented in Section 2. Geophysical techniques used during the investigation are discussed in Section 3. Field procedures are described in Section 4. Data processing and interpretation are discussed in Section 5. The results of the geophysical survey are presented in Section 6, and our professional certification is presented in Section 7.

2 DATA REVIEW

The following information was made available for review during this investigation:

- Report titled "Draft Final Phase II Remedial Investigation Report, Operable Unit 2A - Site 24, Marine Corps Air Station, El Toro, California, Volume 1 and Volume 2, CTO-0073/0314," prepared by Bechtel National, Inc., March 1997. Referenced as Bechtel (1997) in this report.

- Map titled "Proposed Extensions to Runways, U.S. Marine Corps, El Toro, California" prepared by the Public Works Department, dated 1950.

- Map titled "Repairs to Wells and Pumping Equipment, U.S. Marine Corps, El Toro, California", dated 1948?

- Water distribution system utility map, U.S. Marine Corps, El Toro, California, date not available. A portion of this map is included in Appendix A.

The locations of AW-5 and AW-6 are clearly shown on the various base maps identified above. AW-3, however, is not located on any of the base maps. This well is plotted on Figure 2-7 of Bechtel (1997), but the source of data used to plot this well (i.e. interviews, unknown maps, etc.) was not available to **GEO***Vision* at the time of this report. It is possible that AW-3 was never a producing well and, therefore, was not plotted on any base maps.

3 GEOPHYSICAL TECHNIQUES

This section presents background information on the magnetic and EM methods used during this investigation. A description of the geophysical methods used during this investigation. common applications of the methods, photographs of the instruments, and example applications are included in Appendix B.

The magnetometer used during this investigation consisted of a Geometrics G858 optically pumped cesium-vapor magnetometer (G858). This instrument measures the intensity of the earth's magnetic field in nanoteslas (nT) and, optionally, the vertical gradient of the earth's magnetic field in nanoteslas per meter (nT/m). The vertical magnetic gradient is calculated by measuring the total magnetic field with two sensors at different heights, subtracting the top sensor reading from the bottom sensor reading, and dividing by the sensor separation. Buried ferrous metallic objects give rise to anomalies in the earth's magnetic field. These anomalies are generally dipolar with a positive response south and a negative response north of the object. The dimensions and amplitude of a magnetic anomaly are a function of the size, mass, depth, and magnetic properties of the source. Vertical, steel cased wells generally give rise to a monopolar response (large amplitude positive anomaly centered near target with low amplitude negative response to north) with the positive peak several feet south of the well. Magnetometers can typically locate water wells with steel casing to depths of over 10 feet providing background noise levels are not too high and the casing is not extensively corroded. The magnetic anomaly due to a steel-cased water well is expected to have a diameter or greater than 30 feet. Magnetometers are not able to detect nonferrous metals such as aluminum or brass.

EM equipment used during this investigation consisted of a Geonics EM-61 high-resolution digital metal detector (EM-61), Fisher TW-6 metal detector, and a Radiodetection RD-400 and/or Metrotech 9890 EM utility locator. The EM-61 is a high-resolution, deep sensing, time domain EM metal detector. The EM-61 has a single transmitter and two receiver coils. The bottom coil is the transmitter during the current on-time and receiver during current off-time. The top-coil, mounted 40-cm above the bottom coil, is a receiver coil only. The transmitter and receiver electronics controls are mounted in a backpack and a hand-held data logger is used to store field measurements. During operation a half-duty cycle waveform is applied to the transmitter coil. During the off-time the receiver coils measure the decay of eddy currents, in millivolts (mV), produced in subsurface metallic objects by the pulsed primary EM field. The top coil is gained in such a manner that the instrument response to a metallic object lying on the surface will be approximately equal at both the top and bottom coils. The effects of surface debris can, therefore, be suppressed by calculating the differential response (subtraction of the bottom coil from top coil response). Positive EM-61 anomalies centered over the source are typically observed over buried metallic objects. Above ground metallic objects will often give rise to a negative differential response, as the top coil response is larger than the bottom coil response. The EM-61 has a maximum depth of investigation of 8 to 10 feet. This instrument is not generally applied to locating water wells due to its limited depth of investigation; however the instrument can map buried metallic debris and pipes, which may be associated with a well, with much better resolution

than a magnetometer. The EM-61 usually can not locate buried cables, such as electric and telephone lines, due to the minimal amount of metal in copper wire.

The Fisher TW-6 deep-search metal detector operates under similar principles as the EM-31. The instrument operates at a frequency of 82 kHz and transmitter-receiver separation of about 4 feet. The Fisher is useful for locating pipes and buried metallic objects, such as USTs. If is often used to relocate magnetic and EM-61 anomalies and determine the approximate lateral dimensions of the source of the anomaly.

The Radiodetection and Metrotech EM utility locators consist of a separate EM transmitter and receiver and are designed to accurately trace pipes and utility lines. The transmitter can be directly connected to pipes that surface and the pipes traced in conductive mode. Alternatively, the transmitter can be positioned on the surface over a pipe and the pipe traced in inductive mode. The Radiodetection RD-400 is operated at frequencies of 512 Hz, 8 kHz or 33 kHz while the Metrotech 9890 is operated at frequencies of 980 Hz, 9.8 kHz or 88 kHz. Both systems can also be operated in a passive 60-Hz mode to locate live electrical lines.

4 FIELD PROCEDURES

This section describes the field procedures used during the investigation, including site preparation, magnetic and EM-61 survey procedures, and verification of geophysical anomalies.

4.1 Site Preparation

Before conducting the geophysical investigation, maps and other data made available to **GEO***Vision* were reviewed to determine the appropriate location of the geophysical surveys. Wells AW-5 and AW-6 are plotted on several base maps and the geophysical survey areas were approximately centered on these locations. The only available reference to AW-3 was the Bechtel (1997) report, where this well location was plotted on Figure 2-7 and on Plate 3 of the Norcal report in Appendix G. The source of this plotted well location was not available to **GEO***Vision*. The approximate locations of the geophysical survey areas for each well site are shown on Figure 1. The AW-3 survey area consists of an "L" shaped area immediately south of Building 369. The AW-5 survey area is a 200- by 190-foot area northwest of Tank 175. The AW-6 survey area is a 200- by 200-foot area located about 400 feet southeast of the AW-3 survey area.

A 10- by 10-foot survey grid was established in each survey area and marked with surveyor paint. Obvious surface cultural features that could potentially affect the geophysical data (i.e. metallic fences, buildings, reinforced concrete pads, tie downs, utility manholes and vaults, monitoring wells, and other surface metallic objects) were identified in the field and plotted onto scaled, hand-drawn site maps.

A Sokkia GIR1000 single-frequency global positioning system (GPS) was used to survey the corners of the geophysical survey areas and also to survey the interpreted location of any abandoned wells located during this investigation. Differential corrections were applied to the GPS data using GPS base station data recorded at the Sokkia office in Orange, California. GPS data were collected in geodetic coordinates based on the WGS84 system and transformed to approximate California State Plane Coordinates, Zone 6, North American Datum of 1983 (NAD83) after applying differential corrections. Ellipsoid heights measured using the GPS system were converted to NAVD 88 elevations using the Geoid Model of 1996. Maximum horizontal errors in the corrected GPS data are estimated to be about 3 feet, with average errors being about 1 to 2 feet.

4.2 Magnetic Surveys

Magnetic data was acquired at the three abandoned water well sites on May 16 and 17, 2000. Prior to data acquisition at each site, the G858 was programmed with the appropriate line number, direction, sampling interval, and control point spacing. Changes in these parameters were made as necessary during the survey. Measurements of the earth's total magnetic field and/or vertical magnetic gradient were made at 0.1-second intervals as the operator walked along southwest to northeast (SW-NE) survey lines spaced 5 feet apart at the AW-3 and AW-

6 areas and northwest to southeast (NW-SE) survey lines spaced 5 feet apart at the AW-5 area. The 10-foot grid points were used for spatial control. A marker key on the instrument was depressed every time a 10-foot control point was crossed and linear interpolation was used to assign station positions to the intermediate readings. The 0.1-second sampling interval resulted in an average station spacing of about 0.5 feet. The magnetic data were stored in the internal memory of the magnetometer, along with line and station number, and time of measurement. If a location error was made on a survey line (station mark skipped, etc.) the line was deleted from the magnetometer's internal memory and reacquired. Magnetic data were downloaded to a laptop computer at the end of the survey using the program MAGMAP by Geometrics Inc.

4.3 Geonics EM-61 Surveys

EM-61 data was acquired at the three abandoned water well sites on May 16 and 17, 2000. Prior to data acquisitionat each site, the EM-61 was assembled and battery levels were checked and found to be within acceptable levels. The EM-61 digital data logger was then programmed with the appropriate file name, line number, start station, station increment, and direction. Changes in these parameters were made as necessary throughout the survey. EM-61 measurements were made at 2.5-foot intervals along NW-SE survey lines spaced 5 feet apart at the AW-3, AW-5 and AW-6 areas using the 10-foot grid points for spatial control. The EM-61 data were stored in a digital data logger along with line and station number. If an error was made acquiring a line, a note was made in the field log and the line repeated. EM-61 data were downloaded to a laptop computer at the end of the survey using the computer program DAT61 by Geonics Ltd.

4.4 Field Verification

The verification phase of the investigation was conducted on May 22 and June 8, 2000 after preliminary processing of the magnetic and EM-61 data collected at each site. A discussion of data processing procedures is provided in the following section. Significant magnetic and EM-61 anomalies were field checked to verify that they had subsurface sources. The Metrotech and/or Radiodetection EM utility locators and Fisher metal detector were used in an attempt to trace buried pipes and utilities interpreted from the geophysical data. The locations of these pipes were approximately plotted on the site map for the relevant survey area and marked on the ground with surveyor paint. Interpreted abandoned water well locations were marked in the field with stake chasers or surveyor paint, plotted on the appropriate site map, and surveyed with the Sokkia GPS system.

5 DATA PROCESSING AND INTERPRETATION

This section presents the data processing procedures and interpretation of the geophysical data.

5.1 Data Processing

Color-enhanced contour maps of magnetic and EM-61 data were generated using the GEOSOFT® geophysical mapping system. The maps were color-enhanced to aid in the interpretation of subtle anomalies. Prior to map generation, a number of preprocessing steps were completed and included:

- Backup of all original field data files to floppy disk.
- Correcting of all data acquisition errors (typically only deleting the first portion of a reacquired line, renaming lines incorrectly labeled, deleting additional readings outside the grid, etc.)
- Reformatting field data files to free format XYZ files containing line number, station, time (if applicable), and field measurements.
- Applying small adjustments to EM-61 station locations to compensate for data being recorded while the operator was walking.
- Merging of multiple data files into a single file and sorting, if necessary.

The output of the data preprocessing was a data file containing line and station number and the top coil, bottom coil, and differential response. These data files were imported into the GEOSOFT® mapping system and the following data processing steps applied:

- Reformatting of data files to GEOSOFT® format.
- Generating final map scale.
- Gridding data using down- and cross-line splines or minimum curvature.
- Masking grid in areas where data not acquired (i.e. around building).
- Applying a single pass Hanning filter to smooth the data.
- Generating color zone file describing color for different data ranges.
- Contouring the data.
- Generating map surrounds (title block, legend, scale, color bar, north arrow, etc.)
- Annotating anomalies.
- Merging various plot files and plotting final map.

The names of the files generated and the processing parameters used were recorded on data processing forms. All completed data processing forms are retained in project files. All files generated during the processing sequence were archived on digital tape or CD-ROM.

5.2 Interpretation

5.2.1 Abandoned Water Well No. 3 Area

Color-enhanced contour maps of total magnetic field intensity and EM-61 bottom coil response for the AW-3 area are presented as Figures 3 and 4, respectively. The coordinates shown in these figures reference the relative geophysical coordinate system shown in Figure 2. The color bar indicates the amplitude of the measured quantity with the magenta and cyan colors representing high- and low-amplitudes, respectively. The light orange, yellow and light green colors indicate average "background" values of the measured quantity. The vertical or horizontal parallel lines or tick marks show the survey lines or stations along which data were acquired. Vertical magnetic gradient and EM-61 differential response data were also acquired. These data are not presented as they did not provide additional information and were, therefore, considered redundant. Contour maps of these data are, however, retained in project files. A combined interpretation of the geophysical data is presented in Figure 2.

Anomalies in the magnetic and EM-61 data were field checked to determine if a source of metal at the surface caused the anomaly. A number of surface metallic features; such as fences, buildings, reinforced concrete pads, manholes and other surface features associated with utility lines, parking stops, and other metallic surface objects/debris caused anomalies in the geophysical data. These anomalies are labeled as "SM" on the contour maps.

There are several anomalies on the contour maps interpreted as being caused by buried pipes or utility lines. These anomalies are labeled as "P" on the contour maps with approximate locations shown on Figure 2. The pipes are shown as solid lines on Figure 2 where traced with the EM utility locator, dashed lines were interpreted directly from geophysical data, and are queried where uncertain. Asphalt patches indicative of utility trenches are also shown on Figure 2. The utilities in most of these trenches (water and sewer lines based on field observations) are nonmetallic as they did not give rise to magnetic and EM-61 anomalies and could not be traced with an EM utility locator.

There is a small EM-61 anomaly at geophysical survey coordinates 55E, 10N interpreted as being caused by very small, buried metallic objects or debris. This anomaly is labeled as "B" on the contour map (Figure 4) and is probably caused by a very small metallic object at shallow depth. The absence of an associated magnetic anomaly indicates that this EM-61 anomaly is not caused by a steel-cased well.

There is no evidence of an abandoned water well in portions of the survey area where geophysical data is not affected by surface metallic objects, or buried metallic pipes.

5.2.2 Abandoned Water Well No. 5 Area

Color-enhanced contour maps of total magnetic field intensity and EM-61 bottom coil response for the AW-5 area are presented as Figures 6 and 7, respectively. The coordinates shown in these figures reference the relative geophysical coordinate system shown in Figure 5. The color bar indicates the amplitude of the measured quantity with the magenta and cyan

colors representing high and low amplitudes, respectively. The light orange, yellow and light green colors indicate average "background" values of the measured quantity. The vertical or horizontal parallel lines or tick marks show the survey lines or stations along which data were acquired. Vertical magnetic gradient and EM-61 differential response data were also acquired. These data are not presented as they did not provide additional information and were, therefore, considered redundant. Contour maps of these data are, however, retained in project files. A combined interpretation of the geophysical data is presented in Figure 5.

Anomalies in the magnetic and EM-61 data were field checked to determine if a source of metal at the surface caused the anomaly. A number of surface metallic features; such as reinforced concrete pads, runway vaults and lights, and other metallic surface objects/debris caused anomalies in the geophysical data. These anomalies are labeled as "SM" on the contour maps.

There are several anomalies on the contour maps interpreted as being caused by buried pipes or utility lines. These anomalies are labeled as "P" on the contour maps with approximate locations shown on Figure 5. The pipes are shown as solid lines on Figure 5 where traced with the EM utility locator, dashed lines were interpreted directly from geophysical data, and are queried where uncertain. The old water distribution utility map for the base (Appendix A) indicates that the pipe entering the survey area at geophysical survey coordinates 0E, 40N is the abandoned water line leading to AW-5. Several buried utilities (electric, telephone, or communication) that did not give rise to magnetic or EM-61 anomalies were traced with an EM utility locator and are shown on Figure 5. These utility lines are all labeled as electric lines and did not give rise to EM-61 anomalies as the wire does not have sufficient surface area. None of these possible electric lines carried 60 Hz signal at the time of the survey, indicating that they may be inactive.

There are numerous small magnetic and EM-61 anomalies interpreted as being caused by small, buried metallic objects or debris. These anomalies are labeled as "B" on the contour maps and are probably caused by a very small metallic objects or debris at shallow depth.

There are three large geophysical anomalies on the contour maps of magnetic and EM-61 data (Figures 6 and 7) labeled as A-1 to A-3. Anomaly A-1 is a high-amplitude EM-61 anomaly with an associated magnetic anomaly at the end of an abandoned water line. This anomaly is interpreted as being caused by AW-5 or infrastructure associated with the well. The magnetic anomaly from the well appears to be severely distorted by other buried metallic objects in the area, identified as Anomaly A-2.

Anomaly A-2 is a narrow, somewhat linear EM-61 anomaly and high-amplitude magnetic anomaly that appears to be associated with AW-5 in some way. The anomaly is perpendicular to the abandoned water line associated with the well and is probably caused by abandoned pipes or infrastructure associated with the well. The water distribution utility map (Appendix A) does not show a water line corresponding to this anomaly. Anomaly A-3 is a high-amplitude magnetic and EM-61 anomaly centered at geophysical survey coordinates 185E, 172.5N. This anomaly is not related to the water well and is caused by a buried metallic object, probably subsurface infrastructure associated with the runway.

The interpreted location of AW-5 is shown on Figure 5. Several sections of probable abandoned pipe terminate at or near the interpreted well location.

5.2.3 Abandoned Water Well No. 6 Area

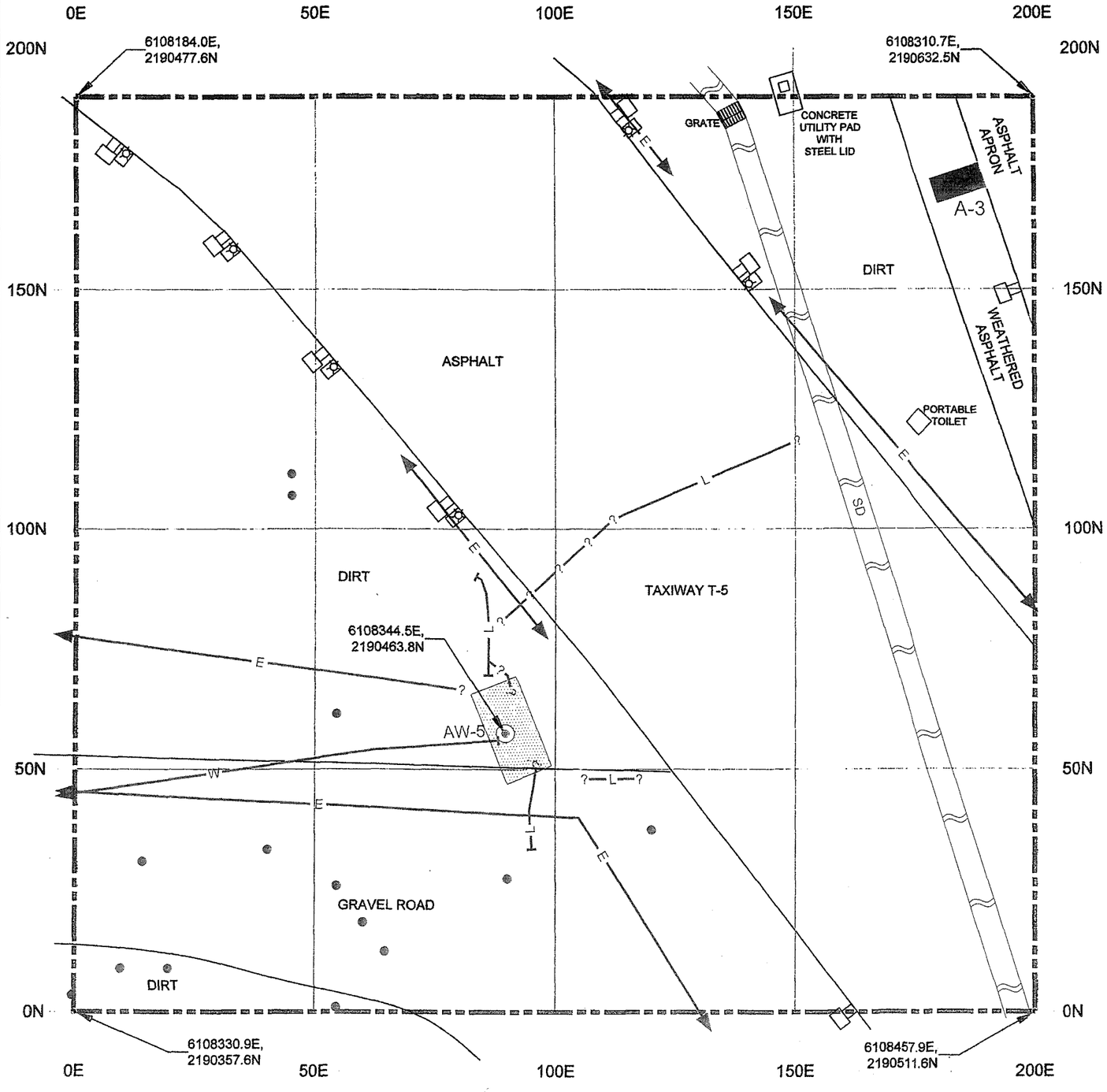
Color-enhanced contour maps of total magnetic field intensity and EM-61 bottom coil response for the AW-6 area are presented as Figures 9 and 10, respectively. The coordinates shown in these figures reference the relative geophysical coordinate system shown in Figure 8. The color bar indicates the amplitude of the measured quantity with the magenta and cyan colors representing high and low amplitudes, respectively. The light orange, yellow and light green colors indicate average "background" values of the measured quantity. The vertical or horizontal parallel lines or tick marks show the survey lines or stations along which data were acquired. EM-61 differential response data was also acquired. This data is not presented as it did not provide additional information and was, therefore, considered redundant. A contour map of this data is, however, retained in project files. A combined interpretation of the geophysical data is presented in Figure 8.

Anomalies in the magnetic and EM-61 data were field checked to determine if a source of metal at the surface caused the anomaly. A number of surface metallic features; such as fences, tie downs, manholes and utility vaults, light posts, monitoring wells, and other metallic surface objects/debris caused anomalies in the geophysical data. These anomalies are labeled as "SM" on the contour maps.

There are several anomalies on the contour maps interpreted as being caused by buried pipes or utility lines. These anomalies are labeled as "P" on the contour maps with approximate locations shown on Figure 8. The pipes are shown as solid lines on Figure 8 where traced with the EM utility locator, dashed lines were interpreted directly from geophysical data, and are queried where uncertain. The old water distribution utility map for the base (Appendix A) indicates that the pipe entering the survey area at geophysical survey coordinates 0E, 100N is the abandoned water line leading to AW-6. Several buried utilities (electric, telephone, or communication) that did not give rise to magnetic or EM-61 anomalies were traced with an EM utility locator and are shown on Figure 8. A gas line inferred from base utility maps is also shown on Figure 8.

There are numerous small magnetic and/or EM-61 anomalies interpreted as being caused by small, buried metallic objects or debris. These anomalies are labeled as "B" on the contour maps and are probably caused by a very small metallic objects or debris at shallow depth.

The geophysical anomaly interpreted as AW-6 is labeled as A-1 on the contour maps of magnetic and EM-61 data (Figures 9 and 10). The source of this anomaly gives rise to the high-amplitude, monopolar magnetic response typical of vertical well casing and a weak EM-61 anomaly. The EM-61 cannot locate well casing deeper than about 8 feet and the EM-61 may be caused by either the well, if shallow enough, or a piece of pipe or other object associated with the well. The magnetic anomaly caused by AW-6 is slightly distorted by the adjacent pipes, making precise location of the casing difficult. Three abandoned pipes appear to terminate near AW-6 as shown on Figure 8.



LEGEND

0N, 0E	RELATIVE COORDINATE SYSTEM OF GEOPHYSICAL SURVEY
	BOUNDARY OF GEOPHYSICAL SURVEY AREA
6108310.7E, 2190632.5N	APPROXIMATE CALIFORNIA STATE PLANE COORDINATES (NAD 83, ZONE 6) FOR SURVEYED POINT
	RUNWAY LIGHT
	RUNWAY VAULT
	VERY SMALL BURIED METALLIC OBJECT / DEBRIS
A-3	SMALL BURIED METALLIC OBJECT / DEBRIS
⊢?—L⟶	UNDERGROUND PIPE, DASHED WHERE APPROXIMATE, QUERIED WHERE UNCERTAIN (E=ELECTRIC, W=WATER, SD=STORM DRAIN, L=UNKNOWN)
AW-5	INTERPRETED LOCATION OF ABANDONED WATER WELL NO. 5
	RECOMMENDED AREA OF EXCAVATION

0 12.5 25 50
(feet)

GEOVision
geophysical services
a division of Blackhawk Geometrics

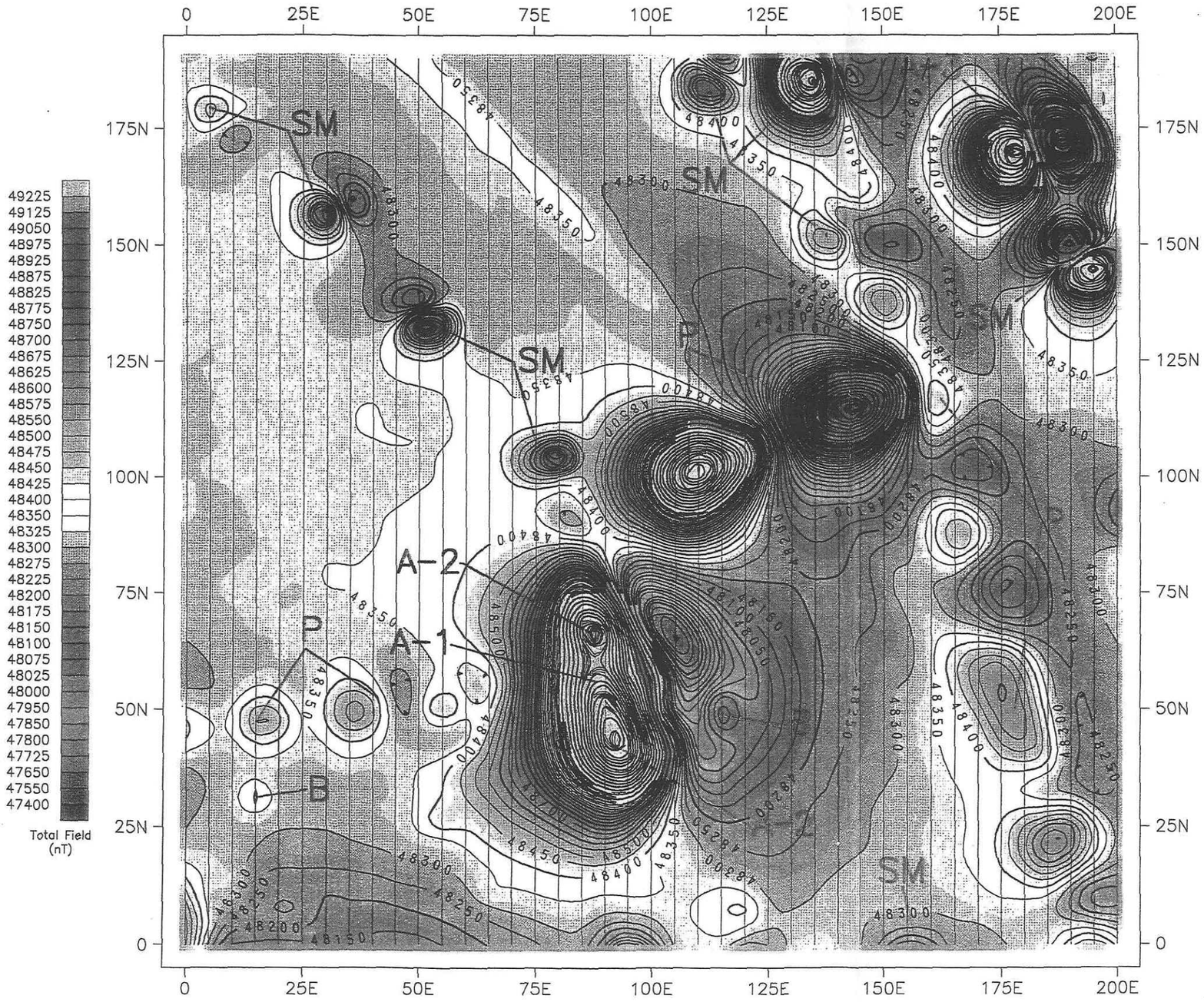
Project #	0260-WW
Date	Jun 16,2000
Developed by	A MARTIN
Drawn by	T RODRIGUEZ
Approved by	
File	C:\AcadMap2K\0260\ww\0260-WW5.dwg

FIGURE - 5

SITE MAP WITH GEOPHYSICAL INTERPRETATION

ABANDONED WATER WELL NO. 5 AREA
MARINE CORPS AIR STATION, EL TORO
ORANGE COUNTY, CALIFORNIA

PREPARED FOR
THE IT GROUP



CONTOUR INTERVAL = 50 NANOTESLAS

LEGEND

25E,25N	RELATIVE COORDINATE SYSTEM OF GEOPHYSICAL SURVEY
———	MAGNETIC SURVEY LINE
A–1	ANOMALY DISCUSSED IN REPORT
B	ANOMALY CAUSED BY A VERY SMALL BURIED METALLIC OBJECT
P	ANOMALY CAUSED BY BURIED PIPE
SM	ANOMALY CAUSED BY SURFACE OBJECT (BUILDING, REINFORCED CONCRETE, FENCE, LIGHT POST, etc.)

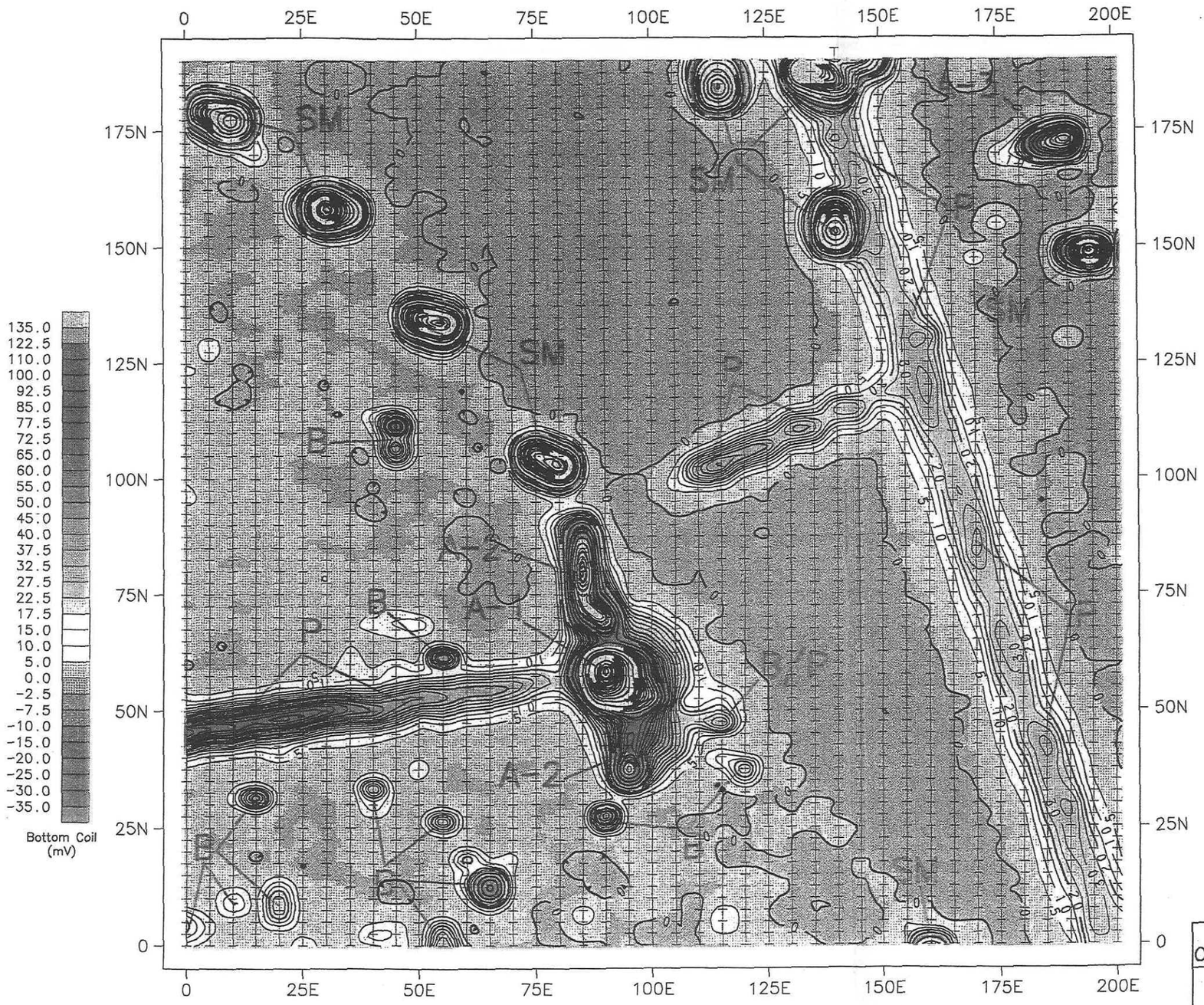
12.5 0 12.5 25
(feet)

FIGURE 6
CONTOUR MAP OF TOTAL MAGNETIC FIELD INTENSITY

ABANDONED WATER WELL NO. 5 AREA
MCAS EL TORO, CALIFORNIA

PREPARED FOR
THE IT GROUP

GEOVISION GEOPHYSICAL SERVICES



CONTOUR INTERVAL = 5 MILLIVOLTS

LEGEND

25E,25N	RELATIVE COORDINATE SYSTEM OF GEOPHYSICAL SURVEY
	GEONICS EM-61 SURVEY LINE
A-1	ANOMALY DISCUSSED IN REPORT
B	ANOMALY CAUSED BY A VERY SMALL BURIED METALLIC OBJECT
P	ANOMALY CAUSED BY BURIED PIPE
SM	ANOMALY CAUSED BY SURFACE OBJECT (BUILDING, REINFORCED CONCRETE, FENCE, LIGHT POST, etc.)

12.5 0 12.5 25
(feet)

FIGURE 7
CONTOUR MAP OF GEONICS EM-61 BOTTOM COIL RESPONSE

ABANDONED WATER WELL NO. 5 AREA
MCAS EL TORO, CALIFORNIA

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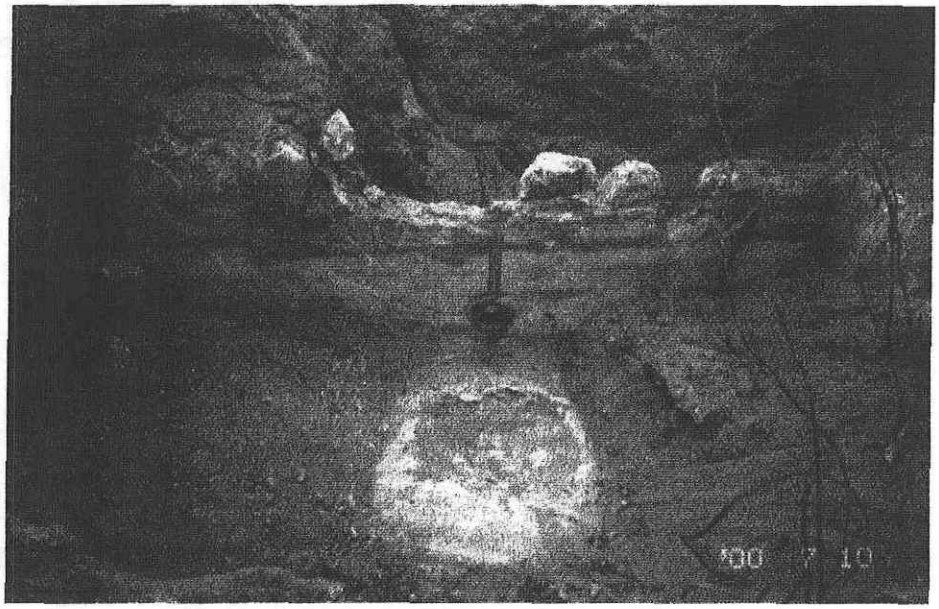
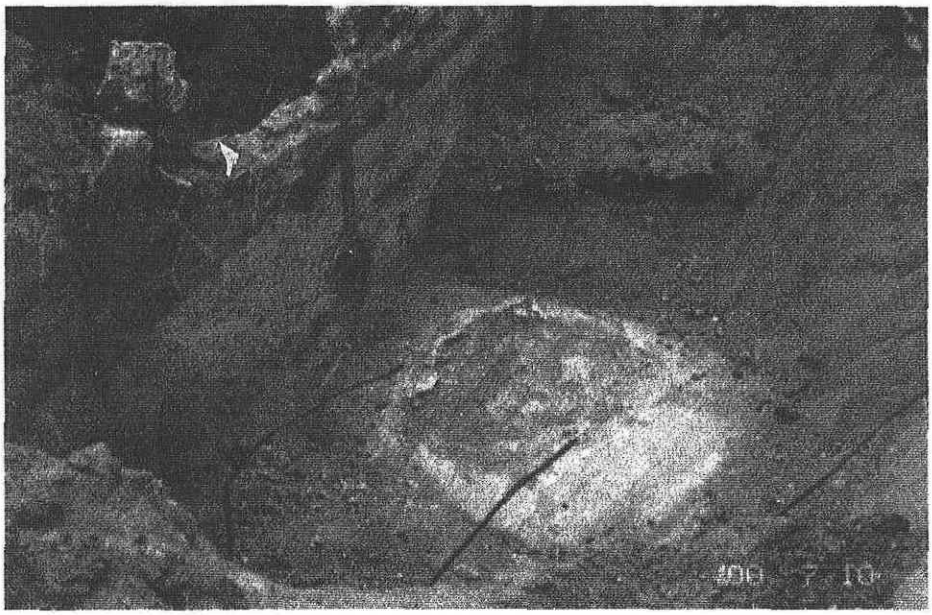
GEOVISION GEOPHYSICAL SERVICES

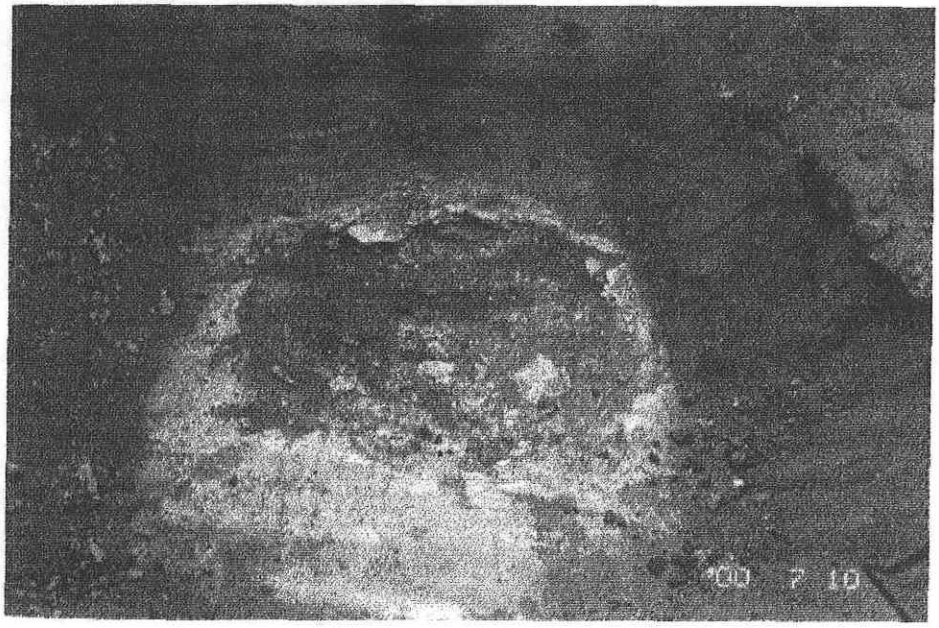
Attachment D
Photographic Log



View of distribution pipe and well vault wall and base.



Base of well vault, view of cement-filled previously destroyed well, AW-5.



Close up of cement-filled well AW-5.

View of vault wall and re-bar.

OHM Remediation Services Corp.
A Subsidiary of OHM Corporation

OHM TRANSMITTAL/DELIVERABLE RECEIPT

CONTRACT N68711-93-D-1459 **DOCUMENT CONTROL NO: SW9166**

TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr Dave Jespersen, Code 57CS1.DJ
Building 131
1220 Pacific Highway
San Diego, California 92132-5101

Date: 14-Dec-00

D.O.: 70

Location: MCAS EL TORO

FROM: Stewart Bornhoft, Program Manager

Edwin G. Bond, Contracts Manager

DESCRIPTION OF ENCLOSURE: *Well Closure Report - Abandoned Water Supply Well No. 5 (AW-5), dated December 12, 2000.*

LIST OF APPENDICES:

TYPE: Contract Deliverable ( ) ($) D. O. Deliverable (**X**) (Tech) Request for Change ( ) Other ( )

VERSION: FINAL **REVISION:** 0

ADMIN RECORD: Yes ( ) No (**X**) Category ( ) Confidential ( )

SCHEDULED DELIVERY DATE: 14-Dec-00 **ACTUAL DELIVERY DATE:** 14-Dec-00

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